What factors influence weight loss in participants of commercial weight loss programmes? Implications for health policy

Madigan, Claire D; Roalfe, Andrea; Daley, Amanda; Jolly, Kate

DOI:
10.1016/j.orcp.2017.06.003

Document Version
Peer reviewed version

Citation for published version (Harvard):
Madigan, CD, Roalfe, A, Daley, A & Jolly, K 2017, 'What factors influence weight loss in participants of commercial weight loss programmes? Implications for health policy', *Obesity Research and Clinical Practice*. https://doi.org/10.1016/j.orcp.2017.06.003

What factors influence weight loss in participants of commercial weight loss programmes? Implications for health policy

Dr Madigan CD, Research Fellow[1], Mrs Roalfe A, Head of Statistics[2], Dr Daley AJ, Reader in Behavioural Medicine[2], Professor Jolly K, Professor of Public Health[2]

[1]The Boden Institute, The University of Sydney, Charles Perkins Centre, Camperdown, New South Wales, 2006, Australia

[2]Institute of Applied Health Research, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK

Corresponding author: Dr Madigan (claire.madigan@phc.ox.ac.uk)

Nuffield Department of Primary Care Health Sciences, University of Oxford, Radcliffe Primary Care, Radcliffe Observatory Quarter, Woodstock Road, Oxford, OX2 6GG

Abstract

Background: Finding effective referral policies for weight management services would have important public health implications.

Aim: Here we compare percentage weight change by referral methods, BMI categories and participants who have had attended weight loss programmes multiple times.

Design and Settings: A prospective cohort study of 15,621 participants referred to 12-week behavioural weight loss programmes funded by the public health service in Birmingham, UK.

Methods: Comparisons were made between GP versus self-referrals, BMI ≥40 kg/m^2 to <40 kg/m^2 and multiple referrals compared to only one referral. Linear mixed modelling was used to assess percentage weight change after adjusting for covariates.

Results: Participant's mean age was 48.5 years, 78.7% were of white ethnicity, 90.3% female and mean baseline BMI was 36.3 kg/m^2. There were no significant differences in percentage weight loss, between participants that self-referred and those that were referred by their general practitioner (GP) and no significant differences between baseline BMI categories. Referral to a weight loss programme more than once was associated with less weight loss at subsequent attendances (0.92%, 95% CI 0.70 to 1.14, p<0.001).

Conclusion: Allowing self-referral to a weight loss programme widens access without compromising amount of weight lost. These programmes are beneficial for all categories of obesity, including those with a BMI ≥40 kg/m^2. Attending weight management programmes more than once results in less weight loss and that swapping to a different program may be advisable.

Key words: obesity, primary healthcare, behaviour, treatment

Introduction

As part of the care pathway for people with obesity it is recommended that patients are referred to multicomponent behavioural weight management programmes, which are often three months duration (1, 2). However, provision varies and need generally outstrips supply. Managing the demand can be explored by examining individual factors that might predict success and previous research has investigated motivation, self-esteem, locus of control, and readiness to change, however there have been inconsistent findings(3). Another method that may be easier to implement by commissioners of weight management services is to examine the service itself. This involves evaluating the programmes being offered, referral criteria and length of programme.

We have previously examined the association between commercial weight loss programmes and found similar outcomes between the programmes; yet there was heterogeneity in the amount of weight loss by individuals(4). Investigating other factors that may influence effectiveness would have important health and commissioning implications. Here we have investigated three factors that may influence weight loss including referral method, body mass index (BMI) category at the start of the programme and multiple attendances at weight loss programmes.

Accessible services are recommended for weight management, and in some areas people are able to self-refer to treatment programmes(4). This is important as it may reduce barriers, result in quicker access to a service and reduce appointments at general practices(5). However there are also advantages of GP referral as this may increase motivation to lose weight(6), although this extrinsic motivation may not help with long term weight loss(7) . Anecdotal reports from the service suggest people feel accountable to their GP as they believe their GP is monitoring their progress, which may mean they are more likely to attend the programme. Qualitative research examining people's experience of a referral letter from their GP to a take part in a randomised controlled trial found that they appreciated this sense

of personal support and the offer of a service(8). However it is not clear whether this results in improved outcomes. Bink and colleagues examined GP versus self-referral to a very low calorie diet (VLCD) or low calorie diet intervention (LCD) and found no difference in treatment outcomes according to the referral methods(9). However, people referred by their GP were less likely to enrol in the programme. This was a small study involving 170 enrolled participants and therefore investigating referral pathways warrants further investigation.

There is a view that community based behavioural weight management programmes may not be suitable for those with a BMI ≥40 kg/m^2 because these people are likely to have more complicated needs and require more specialist support(10). Many community weight management services exclude people with a BMI >40 kg/m^2(11). Current evidence of effectiveness has been limited and mainly in people who are classified as overweight or obese up to a BMI of 40 kg/m^2(12-14). If we can obtain evidence about the effectiveness of these programmes for different categories of BMI we can target resources.

Weight management services can typically be accessed multiple times over a given period, particularly if a person is classified as morbidly obese as they are unlikely to lose sufficient weight in 12 weeks to achieve a healthy body weight. There is some evidence that multiple diet attempts are associated with less weight loss in subsequent attempts(15). An observational analysis of participants attending Weight Watchers found that a second referral resulted in less weight loss(12). However this second referral was usually directly after the first 12 weeks of referral. The rate of weight loss slows over time therefore this is to be expected. Here we have examined whether a second referral at a later point (at least nine months after the end of the weight loss programme) is beneficial for weight loss. There are two things to consider here; firstly, if people are not as successful when they receive further referral to a weight management programme, they may need additional support or a different

service. Alternatively, as obesity is a chronic condition, enabling people to access services again after a period of time may be helpful.

We have investigated the following hypotheses by examining percentage weight change from baseline to 12 weeks:

1. Is self-referral associated with less percentage weight loss than being referred by a GP?
2. Do patients with a BMI ≥40 kg/m^2 have less percentage weight loss than those with a BMI <40 kg/m^2?
3. Are subsequent referrals to weight loss programmes associated with less weight loss at than first referrals?
4. We also completed a sub group analysis to compare only those who had two episodes and examine characteristics and weight change.

Material and Methods

Study Design

A prospective cohort study using anonymised routinely collected data from the Lighten Up service database, a weight management service within Birmingham, United Kingdom. For this study, participants entered the service between January 2008 and November 2014. Throughout the six year period there were different weight loss programmes available, however the numbers attending these programme were very small and many were decommissioned as they were shown to be ineffective(16). To ensure consistency, here, we include only three commercial programmes that have been available throughout the study time period and we have previously shown that they result in similar weight losses at 12

weeks(4). These programmes are Weight Watchers, Rosemary Conley and Slimming World. The content of these programmes have been previously described(4, 17). Participants attended one of these programmes using vouchers paid for by Public Health services for 12 weeks and attended alongside people who paid to attend the programmes. After 12 months participants could re-attend the same programme or choose a different programme for free. These programmes are relatively cheap and cost between £49.50 and £55.00 per 12 week programme compared to £70-100 for General practice and pharmacy led programmes (at 2011 costs) (16).

Setting and recruitment of participants

Eligible people were invited to take part in a weight loss programme by letter from their general practitioner (GP) or during a consultation with a GP, practice nurse or other health care professional or could self-refer. Self-referral was only available from February 2011. People had a raised BMI, defined as BMI ≥25 kg/m^2 for South Asians with no comorbidities or BMI ≥23 kg/$m^2$with comorbidities. All other ethnic groups were eligible if they had a BMI ≥30 kg/m^2 with no comorbidities or BMI ≥28 kg/m^2 with comorbidities. These BMI thresholds made patients eligible for primary care obesity management services. There is evidence to suggest that Asian populations have higher adiposity at lower BMIs but a review of the evidence by NICE failed to reach a conclusion as to what cut-off for Asians would be equivalent to a BMI of 30 in non-Asians(18). However, commissioners needed to set a threshold for eligibility for services(19). Interested or eligible people telephoned a co-ordinating centre, free of charge, where the programme was explained. The telephone co-ordinating centre had a database of times, days and venues of the weight management programmes in the area. People were excluded if they were unable to understand English or were pregnant.

Measurements

We were interested in percentage change in body weight between baseline and 12 weeks (programme end). The weight management provider weighed and took participants height at baseline and 12 weeks. Self-reported weight at 12 weeks was used when an objective measure could not be obtained.

Demographic and baseline information

At baseline, participants reported their age, gender, ethnicity and postcode to the telephone co-ordinating centre staff. Postcode was used to derive the Index of Multiple Deprivation (IMD), which is an area-based measure of the socio-economic status, which were categorised into quartiles (20). BMI was calculated at baseline.

Variables of interest

Referral method: Participants were asked how they were referred to the service and this was recorded as GP, self or other health professional (including dieticians, health trainers and midwives). Referral from a GP could either be in the form of a letter or through a consultation.

Attendance at programmes: Participants accessing the service were allocated a unique code and for every time they attend a weight loss service a new episode is created using the unique code. An episode refers to the referral to a weight loss service. This means that the number of times a person commences a weight loss programme can be identified. The dates of subsequent referrals were checked to ensure that they were at least 12 months after the start date of the previous attendance. The policy for the service stated that subsequent attendance must be 12 months after the start date of the previous weight loss programme. This allowed us to appropriately code participants for this study.

Statistical analysis

Baseline characteristics of the cohort were summarised using descriptive statistics. Subjects were classified into several categories of interest: type of referral (GP, self-referral); BMI (kg/m^2) :< 40, ≥40; and number of referrals (1, 2, 3 or more). There were three other referral methods, but with quite small numbers (24% of the sample for the three referral methods) and therefore not compared with self-referral and GP referral categories.

Prior to imputing missing weights, we compared the characteristics of participants with objective weights recorded to those with self-reported weights using 2-sample t-tests and chi-squared tests. To assess the plausibility of missing weights being missing at random, we also compared the characteristics of those with weight data recorded (objective or self-reported) to those without any weight recorded. Self-reported weights were then imputed where objective weights were missing and multiple imputation (5 replications) utilising all available data was used to impute any additional missing data.

Linear mixed effects model analysis was used to explore the relationship between percentage weight loss over 12 weeks and referral type, BMI and number of weight loss programmes attended. We used percentage weight loss as our dependent variable since this accounts for baseline differences in weight unlike absolute weight loss. Variables considered to be possible confounders (age, gender, ethnicity, attendance and weight loss programme) were included as covariates in the modelling. Some participants had more than one weight loss attempt therefore subject identifier was included as a random effect to allow for the repeated structure of the data. The analysis was rerun on each of the imputed datasets and the results consolidated using Rubin's rules(21). Sensitivity analysis was performed without imputation of missing weight data. Model assumptions of normality and linearity were assessed with

residual plots. Analysis was undertaken with SPSS v22. Results are reported as mean differences with associated 95% confidence intervals.

In a subgroup analysis of only those that had a second episode, we compared end of programme weight of the first episode to baseline weight of the second episode. We also examined whether participants chose a different programme and if this affected weight change through paired t-tests. We also examined the difference in weight change between the first and second episodes using paired t-tests.

Results

There were 15,631 episodes of participants that attended a programme and of these, three participants did not meet the initial weight management criteria (BMI was too low) and therefore excluded. Participants self-reporting a weight gain of greater than 15.0 kg (n=5) or a weight loss of greater than 35 kg (n=2) were excluded from the analyses because 15 kg of weight gain would seem improbable within 12 weeks and some participants had lost 32 kg using objective weights. This resulted in 15,621 participants included in the analyses and of these 10,843 (69.4%) had follow-up weight data at 12 weeks and of these 7.8% were self-reported.

Baseline characteristics

Participants mean age was 48.5 (SD 14.3) years, 78.7% were white, mean BMI at baseline was 36.3 kg/m^2 (SD 6.0) and 86.9% were classified in the two IMD quartiles with greatest deprivation (see Table 1). Only 9.7% of services attendees were male. Generally those with missing weight data at 12 weeks had similar characteristics to those with weight data. An exception to this was that a lower percentage of participants with missing weight data attended Slimming World (Table 2).

Self-referral versus GP referral

Baseline characteristics of the referral groups were similar; apart from a higher proportion of self-referrals chose to attend Slimming World. Most participants were referred by their GP (59%) and 17% self-referred to a programme (24% other referral methods). Following adjustment for age, gender, ethnicity and programme, there was no evidence that GP referral was associated with greater weight loss (0.06% 95% CI -0.2 to 0.3 p=0.595) compared to those who self-referred (Table 3). Of the GP referrals, 5690 participants were referred from a consultation, 2958 from a letter and for 550 participants this was not stated. Participants referred by consultation had an average weight loss of -3.3 kg (SD 3.9) and those referred by a letter lost -3.9 kg (SD 4.0). Attendance at the programs was included in the model and was a significant confounder with greater attendance associated with greater weight loss.

BMI category and weight change

Approximately 22.3% of participants had a BMI ≥40 kg/m^2 and participants were slightly younger and a slightly higher percentage chose to attend Slimming World. After adjustment for confounders, there was no evidence that those with a BMI ≥40kg/m^2 had different percentage weight loss compared to those with a BMI <40 kg/m^2 (0.09% 95% CI -0.06 to 0.24, p= 0.244). Similar results were observed for the completed case analysis.

Multiple referrals to weight loss programmes

Approximately 11% of participants had at least two referrals to weight loss services at least 12 months apart and characteristics between these participants and those who had attended once were similar (Table 1). A very small percentage of participants (2.1%) had attended a programme three times or more with some participants attending up to six times. Second attendance at the programmes was associated with a smaller percentage weight loss difference of 0.92% (95% CI 0.70 to 1.14, p<0.001). Three or more referrals was associated

with even less weight loss (1.4%; 95% CI 0.96 to 1.88, p<0.001) (Table 3). Similar results were observed when missing weights were not imputed.

Examining those who had two episodes (n=1693), on average people had regained the weight lost by the start of the next episode and lost significantly less weight than their first episode (mean difference -0.7 kg 95% CI -1.0 to -0.34, p<0.01) (Figure 1). The majority (59.8%) of participants chose to attend the same programme. However 8.3% of participants' changed from Slimming World to Weight Watchers, 14.1% changed from Weight Watchers to Slimming World, 8.3% from Rosemary Conley to Weight Watchers and 5.4% from Rosemary Conley to Slimming World. Small percentages 2% and 2.1% changed from Slimming World and Weight Watchers to Rosemary Conley. Those who changed programmes lost a similar amount of weight to their first programme (mean difference 0.4 kg (95% CI -0.2 to 0.9 p=0.221). However those who stayed with the same programme lost 1.2kg (95% CI -1.6 to -0.8 p=<0.01) less in their second programme.

Discussion

Summary

This research has investigated factors associated with weight loss that could inform health policy decisions about commissioning weight management services. Being referred by a GP, or self-referral, were associated with the same amount of weight loss. Therefore both GP and self-referral are appropriate options for commercial weight loss services. Self-referral options may result in greater accessibility for those able to do so. Participants with a higher BMI can benefit from this type of service as well, at lower cost, before progression to more intensive specialist services if needed. Participants lost significantly less weight in subsequent referrals to the programme (0.92%, 95% CI 0.70 to 1.14, p<0.001). If a person has two attempts at the programme this difference would not be clinically significant. However for each subsequent

attendance there would be less weight loss each time and accumulatively this amount would be clinically significant. Limiting access may be one method commissioners could use to manage the considerable demand for health services. Greater attendance was significantly associated with greater weight loss and thus participants should be made aware of this and GP's could encourage attendance at programs.

Strengths and limitations of this study

These analyses provide evidence for commissioners of weight management services about referral methods and are also relevant to GPs who refer patients to weight management services. Approximately 30% of participants had missing weight data at programme end and this could have introduced follow-up bias. Similar rates were found across programmes and we limited the effect of this by using a conservative approach to imputing missing weight data and found no differences in baseline characteristics of those with and without missing weight data. Data were only analysed at 12-week follow-up, which is relatively short, however we believe it is appropriate for the purposes of this study, which aimed to look at policy implications for commissioning weight management services, which are usually 12 weeks duration. Continued support is associated with greater weight loss but cost of programmes may limit the services available(22). Self-referral was only available from 2011; however there is no reason to believe it would affect the outcomes investigated. The analysis had a very large sample size and utilises data from a service being implemented in practice and therefore has high ecological validity. There were a small proportion of men who accessed the services and this needs to be taken into account when considering this as a method of treatment. Other methods may be needed to accommodate men or make these services more appealing to them(23).

Comparison with existing literature

We hypothesised that there would be an association between GP referral and greater weight loss due to people feeling more motivated and accountable to a GP. One explanation for no difference in weight loss is that the perceived accountability does not exist or that the weekly group sessions in the programmes may supersede this accountability. Participants report that the weekly weigh-ins in these types of programmes are important to keep them on track(24). Additionally follow-up by GPs was not required and this could be important as found in qualitative interviews of an RCT of referral to a weight loss programme. Participants who were followed up at the practice reported a sense of wishing to please the GP by losing weight(8). Therefore a combination of a shared-care approach may be beneficial, where patients can be referred to a service but their GP continues to clinically assess them. There was also no measure of the relationship between the GP and the patient, which may have influenced the feeling of accountability. On the other hand it could be suggested that those who self-refer might be highly motivated to try and lose weight. Binks and O'Neil measured motivation and found those who self-referred had greater motivation than those referred by their GP and this resulted in greater enrolment by self-referrals(9). However the intervention was a VLCD and LCD and many people may not wish to do this, people may have to be very highly motivated. Those referred by their GP may have not been as well informed about what was involved compared to those who self-referred.

Although no difference was found between referral methods, we recognise GP advice for weight loss is beneficial. GPs may encourage those who are not considering weight loss to make changes and therefore both referral methods should be used to enable people to access weight management services(6, 25, 26).

Our findings suggest that these community programmes help people with higher BMIs to lose weight. A large audit of Slimming World found similar findings, in that percentage weight loss was similar across categories of BMI(27). This audit did not specifically consider

participants with a BMI >40 kg/m^2 compared to lower BMI categories. Participants with a greater BMI will have more weight to lose; therefore a 12-week referral may not be long enough to help them reach a healthy weight. This is an issue that commissioners may need to consider. Some programmes do offer additional sequential referrals for people with a higher BMI if they lose at least 5% of their initial weight loss in the first referral which may be helpful.

Subsequent referral to a weight loss programme (at least 12 months later) resulted in less weight loss at each attendance. Participants that attended the service regained the weight initially lost and therefore it is not surprising they seek further help for weight loss but perhaps different support needs to be offered. This difference between a first referral and a second referral was 1%, which may not be clinically significant, but with a third referral this increased to 1.4% and accumulatively this may have clinical implications. In the sub group analysis we found that changing programme results in similar weight losses to the first programme and it might be hypothesised that they people are gaining additional strategies that they don't receive from their first programme. Although 59% of participants returned to the same programme they lost significantly less weight the second time, it would be interesting in future research to identify their reasons for doing this. Reducing the number of times people can access the same weight management service could be used as a method of addressing the increasing demand, particularly as participants lose less weight. It also suggests that a number of services should be offered to manage this chronic condition.

Weight was the main outcome of interest and this is because greater weight loss is associated with improved health benefits(28). Previous research has found that commercial weight management programmes resulted in greater improvements in insulin sensitivity and total cholesterol compared to primary care programmes(29). The same trial examined quality of life and there were inconclusive findings(30). Another research trial has found that even

modest weight losses of 2 kg for short periods of time reduced the incidence of cardiovascular events and mortality over the subsequent five years(31). Thus there may be long term benefits of helping people to lose weight even if it is for a short period of time and these types of programmes help people to manage their weight.

Implications for research and practice

Commissioners can use the evidence presented here to inform referral guidelines for weight management services. Allowing self-referral to a weight loss programme widens access without compromising amount of weight lost. BMI categories are associated with similar weight losses and therefore GPs/ health professionals can refer participants to these community weight loss services. Multiple referrals at the same weight loss services result in less weight loss each time and other services may need to be considered.

Conflicts of interest

CM and AR have no conflict of interest. AJD, and KJ are participating in trials in which commercial weight management companies provide free treatment courses to participants as a benefit to the NHS but not to the authors personally.

Ethics: As this is data from a service and anoynmised, ethical review was not required as according to the Research Governance Framework for Health and Social Care.

Contributions

All authors designed the study, CM conducted the analyses under the guidance of AR. CM wrote the manuscript and all authors edited and approved the final version.

Acknowledgements

We thank Birmingham Public Health services and Gateway Family services for access to the data. Kate Jolly is part-funded by the National Institute for Health Research (NIHR)

Collaborations for Leadership in Applied Health Research and Care (CLAHRC) West Midlands. The views expressed are those of the authors and not necessarily those of the NIHR, the NHS or the Department of Health. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

1. Hartmann-Boyce J, Johns D, Aveyard P, Onakpoya I, Jebb S, Phillips D, et al. Managing overweight and obese adults: update review. NICE; 2013.
2. NHMRC. Clinical Practice Guidelines for the Management of Overweight and Obesity in Adults, Adolescents and Children in Australia. In: Council. NHaMR, editor. Melbourne2013.
3. Lazzeretti L, Rotella F, Pala L, Rotella C. Assessment of psychological predictors of weight loss: How and what for? World J Psychiatry. 2015;5(1):66-7.
4. Madigan CD, Daley AJ, Lewis AL, Jolly K, Aveyard P. Which weight-loss programmes are as effective as Weight Watchers? Non-inferiority analysis. Br J Gen Pract. 2014;64(620):e128-36.
5. Gaynor K, Brown JSL. Self-referrers to community workshops: Who are they and why do some participants not consult with their GP about their mental health difficulties? Journal of Mental Health. 2013;22(3):227-36.
6. Jackson SE, Wardle J, Johnson F, Finer N, Beeken RJ. The impact of a health professional recommendation on weight loss attempts in overweight and obese British adults: a cross-sectional analysis. BMJ Open. 2013;3(11).
7. Ryan R, Deci E. Self-determination theory and the facilitation of intrinsic motivation, social development and well-being. American Psychologist. 2002;55(1):68-78.
8. Allen J, Cohn S, Ahern A. Experiences of a commerical weight-loss programme after primary care referral: a qualitative study. Br J Gen Pract. 2015;65(633):e248-e55.
9. Binks M, O'Neil P. Referral sources to a weight management program relation to outcome. J GEN INTERN MED. 2002;17:596-603.
10. Centre NCG. Obesity: Identification, assessment and management of overweight and obesity in children, young people and adults. London; 2014.
11. Research G. Practical and process issues in the provision of lifestyle weight management services for adults. Centre for Public Health Research; 2013.
12. Ahern AL, Olson AD, Aston LM, Jebb SA. Weight Watchers on prescription: An observational study of weight change among adults referred to Weight Watchers by the NHS. BMC. 2011;11(434).
13. Stubbs JR, Pallister C, Whybrow S, Avery A, Lavin J. Weight Outcomes Audit for 34,271 adults referred to a primary care/commercial weight management partnership scheme. Obes Facts. 2011;4:113-20.

14. Barte JCM, Veldwijk J, Teixeira PJ, Sacks FM, Bemelmans WJE. Differences in weight loss across different BMI classes: a meta analysis of the effects of interventions with diet and exercise. IntJ Behav Med. 2014;21:784-93.
15. Teixeira PJ, Silva MN, Coutinho SR, Palmeira AL, Matta J, Vieira PN, et al. Mediators of Weight Loss and Weight Loss Maintenance in Middle-aged Women. Obesity. 2010;18(4):725-35.
16. Jolly K, Lewis A, Beach J, Denley J, Adab P, Deeks JJ, et al. Comparison of range of commercial or primary care led weight reduction programmes with minimal intervention control for weight loss in obesity: Lighten Up randomised controlled trial. BMJ. 2011;343.
17. Jolly K, Daley A, Adab P, Lewis A, Denley J, Beach J, et al. A randomsised controlled trial to compare a range of commercial or primary care led weight reduction programmes with a minimal intervention control for weight loss in obesity: the Lighten Up trial. BMC Public Health. 2010;10:439.
18. NICE. Assessing body mass index and waist circumference thresholds for intervening to prevent ill health and premature death among adults from black, Asian and other minority ethnic groups in the UK. 2013.
19. NICE. Obesity Guidance on the prevention, identification, assessment and management of overweight and obesity in adults and children. In: 43 NCG, editor. 2006.
20. Noble M, McLennan D, Wilkinson K, Whitworth A, Barnes H, Dibben C. The English Indices of Deprivation 2007. In: Government CaL, editor. London 2008.
21. Rubin D. Multiple Imputation for Nonresponse in Surveys. New York: John Wiley and Sons; 2004.
22. Hartmann-Boyce J, Johns DJ, Jebb SA, Aveyard P, Behavioural Weight Management Review G. Effect of behavioural techniques and delivery mode on effectiveness of weight management: systematic review, meta-analysis and meta-regression. Obesity Reviews. 2014;15(7):598-609.
23. Robertson C, Archibald D, Avenell A, Douglas F, Hoddinott P, Van Teijlingen E, et al. Systematic reviews and integrated report on the quantitative, qualitative and economic evidence base for the management of obesity in men. Health Technol Assess. 2014;18(35).
24. Ahern A, Boyland E, Jebb S, Cohn S. Participants' explanatory model of being overweight and their experiences of 2 weight loss interventions. Ann Fam Med. 2013;11(3):251-7.
25. Rose SA, Poynter PS, Andersen JW, Noar SM, Conigliaro J. Physician weight loss advice and patient weight loss behavior change: a literature review and meta-analysis of survey data. Int J Obes. 2013;37:118-28.
26. Lewis AL, Aveyard P, Jebb SA. Brief interventions for weight loss in primary care. Curr Obes Rep. 2013;2(4):341-7. English.
27. Stubbs RJ, Brogelli D, Barber J, Pallister C, Whybrow S, Avery A, et al. Service evaluation of weight outcomes as a funciton of initial BMI in 34271 adults referred to primary care/commerical weight management partnership scheme. BMC Res Notes. 2013;6:161.
28. Wing R, Lang W, Wadden T, Safford M, Knowler W, Bertoni A, et al. Benefits of Modest Weight Loss in Improving Cardiovascular Risk Factors in Overweight and Obese Individuals with Type 2 Diabetes Care. Diabetes Care. 2011;34:1481-6.
29. Jebb SA, Ahern AL, Olson AD, Aston LM, Holzapfel C, Stoll J, et al. Primary care referral to a commercial provider for weight loss treatment versus standard care: a randomised controlled trial. The Lancet.378(9801):1485-92.
30. Fuller N, Colagiuri S, Schofield D, Olson A, Shrestha R, Holzapfel C, et al. A within-trial cost-effectiveness analysis of primary care referral to a commercial provider for weight

loss treatment, relative to standard care--an international randomised controlled trial. International Journal of Obesity. 2013;37(6):828-34.
31. Caterson I, Finer N, Coutinho W, Van Gaal L, Maggioni A, Torp-Pedersen C, et al. Maintained intentional weight loss reduces cardiovascular outcomes: results from the Sibutramine Cardiovascular OUTcomes (SCOUT) trial. Diabetes, obesity & metabolism. 2012;14(6):523-30.

Table 1: Characteristics of participants by differing categories

N	**Total**	**Self-referral n=2602**	**GP referral n=9198**	**One attendance n=13603**	**Two attendances n=1691**	**3 or more attendances n=327**	**BMI< 40 kg/m^2 n=9362**	**BMI ≥ 40 kg/m^2 (n=2731)**
Age mean (SD)	48.5 (14.3)	47.1 (13.8)	49.3 (14.5)	48.2 (14.4)	49.9 (13.7)	52.5 (13.2)	50.1 (14.4)	47.6 (13.5)
Gender %								
Male	9.7	187 (7.2)	11.0	10.2	6.7	5.8	10.2	10.3
Baseline BMI kg/m^2								
mean (SD)	36.3 (6.1)	36.6 (6.2)	36.2 (6.0)	36.2 (6.1)	36.8 (6.3)	36.1 (5.0)	33.7 (3.4)	45.1 (4.8)
Programme %								
Rosemary Conley	16.2	8.8	17.6	16.9	11.4	12.2	16.8	10.4
Slimming World	50.2	65.4	46.9	49.7	53.8	55.0	50.9	59.6
Weight Watchers	33.6	25.7	35.5	33.5	34.8	32.7	32.3	30.0
Ethnicity %								
White	78.7	74.0	80.2	78.8%	78.7%	78.6	80.1	81.1
IMD %								
50% most deprived	87.2	87.5	86.3	86.8	88.1	86.9	85.5	90.0
Weight change kg								
mean (SD)	-4.9 (3.9)	-4.6 (3.9)	-5.0 (3.9)	-5.0 (3.9)	-3.9 (3.6)	-3.5 (3.7)	-4.5 (3.5)	-5.8 (4.6)
Weeks of attendance	6.3 (4.0)	6.7 (4.0)	6.2 (4.0)	6.4 (4.0)	6.0 (3.9)	5.9 (3.9)	7.5 (3.8)	7.6 (3.6)

Table 2: A comparison of those with complete self-reported weight data and missing weight data at 12 weeks.

	Self reported weight n=1212	**Measured weight data n=9631**	**Missing weight data n= 4778**
Age mean (SD)	50.4 (14.1)	49.1 (14.2)	46.7 (14.3)
Gender – male n (%)	133 (11.0)	1017 (10.6)	371 (7.8)
Baseline BMI kg/m^2 mean (SD)	36.6 (6.2) n=1210	36.5 (6.2) n=9630	34.1 (3.9) n=1267
Programme n (%)			
Rosemary Conley	174 (14.4)	1505 (15.6)	847 (17.7)
Slimming World	742 (61.2)	5107 (53.0)	1997 (41.8)
Weight Watchers	296 (24.4)	3019 (31.3)	1934 (40.5)
Ethnicity n (%)			
White	936 (77.2)	7817 (81.2)	1814 (81.2)
IMD n (%)			
Most deprived 50%	1040 (85.8)	8367 (86.9)	4178 (87.4)
Weight change baseline to 12 weeks **kg** mean (SD)	-5.1 (4.3)	-4.8 (3.8)	___

Key: SD: standard deviation, IMD: index of multiple deprivation

Table 3: Percentage weight change outcomes by interest

	Percentage weight change kg (95% CI)[a]	**Percentage weight change kg imputed (95% CI)[a]**
GP referred versus self-referral	0.20 (0.003 to 0.39) p=0.046	0.06 (-0.18 to 0.30) p=0.595
BMI <40 kg/m^2 versus≥ 40 kg/m^2	-0.09 (-0.25 to 0.07) p=0.261	0.09 (0.06 to 0.24) p=0.244
Attendance 1 versus 2	1.0 (0.76 to 1.20) p<0.001	0.92 (0.70 to 1.14) p<0.001
Attendance 1 versus 3 or more	1.35 (0.84 to 1.85) p<0.001	1.41 (0.96 to 1.88) p<0.001

[a]Adjusted for age, gender, ethnicity, weight loss programme, attendance

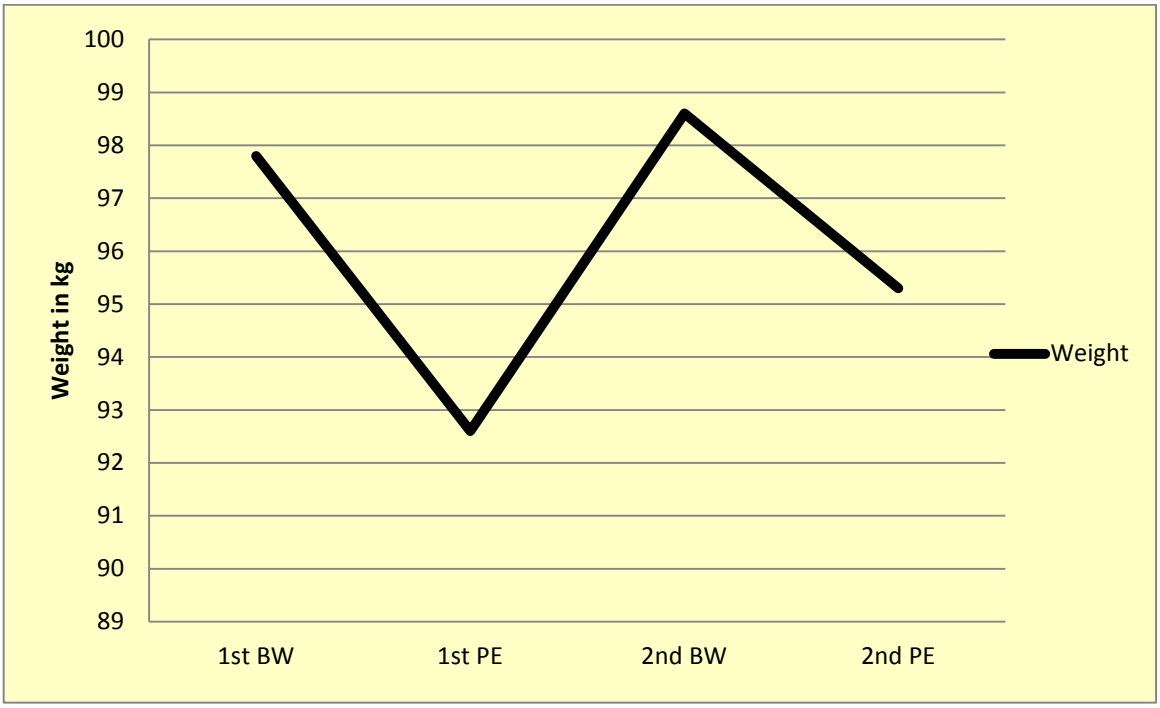

Figure 1: The mean weight change from the start of a first referral to a weight loss programme to the end of the programme, followed by the starting weight at the beginning of a second referral to a weight loss programme and the change by programme end.

BW= weight at baseline of programme
PE= weight at programme end
1st = First referral
2nd = Second referral